

TABLE OF CONTENTS

CHAPTER	TITLE	PAGE
	DECLARATION	ii
	DEDICATION	iii
	ACKNOWLEDGEMENTS	iv
	ABSTRACT	vi
	ABSTRAK	vii
	TABLE OF CONTENTS	viii
	LIST OF TABLES	xii
	LIST OF FIGURES	xiii
1	INTRODUCTION	
	1.1 Background	1
	1.2 Problem Statement	1
	1.3 Objective of the Project	2
	1.4 Scope of the Project	3
2	LITERATURE REVIEW	4
	2.1 Aluminium and its alloys	4
	2.1.1 Classification of Aluminium Alloys	5
	2.1.1.1 Casting Alloys	6

2.1.1.2	Wrought Alloys	7
2.1.2	Applications of Aluminium Alloys	8
2.2	Al-Si Casting alloys	8
2.2.1	Solidification of Al-Si Alloys	9
2.2.2	Cooling curve	11
2.2.3	Aluminum – silicon – LM6 alloys	12
2.2.4	Hypereutectic Al-Si Alloys	15
2.2.5	Grain Refinement of Hypereutectic	16
2.2.6	Modification of Al-Si Alloys	18
2.2.7	Chemical modification	20
2.3	Nucleation	22
2.3.1	Homogeneous nucleation	23
2.3.2	Heterogeneous nucleation	23
2.4	Growth	24
2.4.1	Solidification of dendrite	25
2.4.2	Shrinkage solidification	27
2.4.3	Chvorino's Rule	27
2.6	Lost Foam Casting (LFC)	28
2.6.1	Preparation of bead of polystyrene	29
2.6.2	Pattern Making	30
2.6.3	Coating	30
2.6.4	Sand filling and vibration , compaction	31
2.6.5	Lost Foam Filling Mechanism	32
2.7	Parameters affecting on LFC	33
2.7.1	Degree of vacuum	33
2.7.2	Permeability pattern coatings	34
2.7.3	Pressure	35
2.7.4	Pouring temperature	35

3	RESEARCH METHODOLOGY	36
3.1	Introduction	36
3.1.1	Pattern making	38
3.1.2	Pattern coating and dry	39
3.1.3	Sand filling and vibration	41
3.1.4	Temperature measurement	43
3.1.5	Melting procedure and casting	44
3.2	Analysis	46
3.2.1	Casting analysis	46
3.2.2	Microstructure Analysis	47
3.2.2.1	Simple preparation	47
3.2.2.2	Image Analysis (Eutectic Spacing Measurements)	48
3.2.3	Mechanical properties	49
3.2.3.1	Tensile test	49
3.2.3.2	Vickers Hardness	51
4	RESULTS AND DISCUSSION	52
4.1	Introduction	52
4.2	Casting analysis	52
4.3	Microstructure	55
4.4	Mechanical properties	63
4.4.1	Hardness test	63
4.4.2	Tensile test	64
5	CONCLUSIONS AND FUTURE WORK	69
5.1	Conclusions	69
5.2	Recommendations for future work	70
	REFERENCES	71

LIST OF TABLES

TABLE NO	TITLE	PAGE
2.1	The general characteristics of aluminium	5
2.2	Cast aluminum alloy groups	6
2.2	Wrought aluminum alloy groups	7
2.3	Applications of cast aluminium	7
2.4	Some properties of possible modifier	19
3/1	Chemical composition of LM6 Alloy	41
3.2	TENSILE STRENGTH & HARDNESS	47

LIST OF FIGURES

FIGURE NO	TITLE	PAGE
2.1	Phase diagram of Al-Si alloy	9
2.2	Types of microstructures that may form during Solidification of a casting	10
2.3	cooling curve for a hypo hypereutectic alloy	11
2.4	Aluminum – silicon phase diagram and microstructures	12
2.5	Cooling curve of a cooled metal.	13
2.6	Methodology for measurement of DAS	16
2.7	Optical micrographs showing the various phases observed	17
2.8	Microstructure of a (a) unmodified and (b) modified Hypoeutectic Al–Si alloy	18
2.9	The variation of free energy with radius of nucleus	21
2.10	Transition of growth morphology	23
2.11	Schematic illustration of three basic types of cast structures	24
2.12	Lost foam steps	27
2.13	Lost foam process	29
2.14	Schematic of molten metal front in LFC	30
2.15	IShikawa cause effect diagram of LFC process	31
3.1	experimental steps	35
3.2	Pattern dimensions	36
3.3	Sections of the pattern	37

3.4	coating mixer	38
3.5	flow cup	38
3.6	patterns after coating	38
3.7	Flask position	39
3.8	sand filling and vibration	41
3.9	Shaft used to mixed the TiB	42
3.10	induction furnace	43
3.11	Pouring of castings	43
3.12	Sample preparation for microstructure analysis	44
3.13	Method showing the measurement of eutectic spacing	45
3.14	Tensile specimens test dimensions	46
4.1	Castings using 16, 20 and 32 foam density	51
4.2	Effect of pouring temperature on microstructure on untreated LM6	52
4.3	Effect of pouring temperature on microstructure on TiB-treated LM6 alloy	53
4.4	Effect of pouring temperature on microstructure on untreated and TiB-treated LM6 alloy cast at 740C° for 3, 12 and 24 mm sections	54
4.5	Effect of pouring temperature on eutectic spacing in 3mm thickness (fast cooling rate) for unmodified casting	55
4.6	Effect of pouring temperature on eutectic spacing in 3mm thickness (fast cooling rate) for grain refined casting	56
4.7	Effect of pouring temperature on eutectic spacing in 12mm thickness for unmodified casting	56
4.8	Effect of pouring temperature on eutectic spacing in 12mm thickness for grain refined casting	57
4.9	Effect of pouring temperature on eutectic spacing in 24mm thickness (lower cooling rate) for unmodified casting	57
4.10	Effect of pouring temperature on eutectic spacing in 24mm thickness (lower cooling rate) for grain refined casting	58

4.11	Effect of pouring temperature, section thickness and grain refiner on eutectic spacing	59
4.12	Effect of pouring temperature on hardness	60
4.13	Some of the defects observed in the castings (gas porosity, penetrate of coating into the metal and shrinkage)	61
4.14	Effect of pouring temperature on experimental tensile strength	62
4.15	Comparison of experimental and theoretical tensile strength as function of pouring temperature	63
4.16	Effect of pouring temperature on theoretical tensile strength	63